isobars by interpolation between those already drawn on the map, which new isobars shall represent the pressures, 27.99 inches, 28.37 inches, etc., as given at the heads of the respective columns of the above table. Where the new isotherm of 75.2° intersects the isobar, 27.99 inches, we have a point that may be marked as belonging to the upper isobar of 15.82 inches. Another point on this same isobar will be the intersection of the isotherm 63.7° F. with 28.37 inches; another point will be the intersection of 52.7° with 28.74 inches, etc. By joining these points, therefore, we have at once the upper isobar of 15.82 inches. In this way the laborious computation is wholly avoided, and the entire process consists simply in drawing on the original chart two new sets of isobars and isotherms properly related to each other as required by the above table, so that by joining the intersections of these new curves we at once construct the upper isobars.

Usually the principal source of uncertainty in the upper isobars is due to the temperature assumed for the 2,500 meter level and it is very possible that there may be an error of 10° F. in this datum; the above table shows that such an error will affect the upper isobar by about 0.2 inch, but the error will probably be quite symmetrical over large regions and will, therefore, not seriously affect the general contour of these isobars or the gradients between them.

Bearing in mind this uncertainty of the temperature, the accompanying Chart VII was constructed in 1895, according to the above method, from the charts given by Buchan in his Report on Atmospheric Circulation which is Part V of the Physics and Chemistry of the second volume of the Scientific Results of the Voyage of H. M. S. *Challenger*. Buchan's maps represent the normal data for December for the Northern Hemisphere. His isobars represent pressures reduced to standard gravity. In order to avoid confusion the sea-level isobars and isotherms have been omitted from Chart VII and only the upper-level isobars for 5,000 meters are shown. These upper isobars evidently constitute a single system from the equator to the polar regions. The special oceanic low pressures, which are a marked feature in the North Atlantic and North Pacific in December, almost disappear, being represented only by a widening of the upper isobars for a short distance between Iceland and France and in Bering Sea. On the other hand the continental areas of high pressure are now converted into smooth isobars tending to low pressures.

These upper isobars represent the result rather than the cause of the general circulation of the atmosphere. If it were not for the irregular resistances and temperatures over the continents and oceans we should undoubtedly have symmetrical circular isobars representing a maelstrom with the north pole at the centre and due to the general flow of the upper air from the equatorial belt toward and around the polar regions. As it is, however, the warmer temperature, the moisture, and the absence of special resistances, over the North Pacific and the North Atlantic oceans, combine with the low temperature, the dryness and the large resistances over the Eastern and Western continents, to produce winds that determine an oval system of upper isobars whose longest axis reaches from Hudson Bay toward the northwest over the polar regions into eastern Siberia and the valley of the Lena. If the temperature of the column of air has been assumed too low in the northern regions, as is rather likely, then our upper isobars may be a little too low and upper gradients too steep, but with due allowance for this uncertainty it still remains true that the presence of the great continents has distorted the symmetrical circles into very long ovals. The general path of a particle of atmosphere at this upper level can be approximately estimated from these upper isobars; it must be steadily descending in its circulation around the Arctic regions and the principal places of descent must be over the continents, *i. e.*, in the valley of the Mackenzie and upper Missouri, as it tries to turn the sharp curve at the American end of the oval and, again, over northern Russia and Siberia, as it tries to turn the sharp curve in the upper isobars over China and Siberia.

The study of these upper isobars explains the fact that the high pressure areas of North America in the first part of their course are usually observed to move from the northwest while similar areas in Europe move at first from the southwest but afterwards from the west. The great area of high pressure and cold, clear weather that prevailed over southern Europe November 17-27, finally disappearing over Persia, is a good example of such motion eastward; as a result it is quite possible that this area may have brought to upper India light snow, followed by cold, dry weather, about the 1st of December, 1896.

The upper currents over the North Pacific drive a mass of air eastward or southeastward over Alaska and British America, where it settles down, and by reason of its greater coldness, density, and centrifugal force, is driven southward as cold waves over the United States. Similarly, the strong west current over the North Atlantic forces a mass of air over Sweden and Russia that must eventually spread southeastward either as a "buran" over Siberia and China, or as a cold wave over Persia into northern India. At the surface of the Eastern and Western continents there is a flow of cold, dry air southeastward (sometimes southwestward) that is the mechanical consequence of the locations of the two oceans in respect to these continents, by reason of which the west and southwest winds have free sweep over the oceans on the west. By this arrangement Ferrel's symmetrical circulation over an ideal smooth globe, which would always represent a condition of unstable equilibrium and numerous discontinuous motions, is converted into an almost stable system of circulation during December, January, and February; not indeed a perfectly stable, steady motion, but an approximation thereto which would doubtless become perfect if the winter season lasted continually.

THE TENNESSEE RIVER AND FLOOD SYSTEM.

Mr. L. M. Pindell, Weather Bureau observer, in charge of the Chattanooga station and Tennessee River and Flood Service, has just published a general report, with the permission of the Chief of the Bureau, and by means of funds contributed by the business men of Chattanooga. The object of the report is to give the public all the information collected, and to so classify the data that any one can use the same with success. Besides giving all detailed river data for ten stations, and a special report on the flood of April, 1896, there are some interesting general paragraphs relative to other floods, and the following, which we quote, relative to the general regimen of the Chattanooga watershed:

> The waters from Virginia and North Carolina help to feed the volume of the Tennessee River at Chattanooga, and eventually pass into the Cumberland River at Paducah, Ky. The French Broad, Holston, and Clinch rivers are the most important factors in furnishing the Tennessee her water supply. The Little Tennessee is also an important river, but the rise in this tributary, while of considerable height and importance, does not affect the main body of the Tennessee River like the Clinch or French Broad. The Hiawassee is a very quick and rapid rising tributary. It sometimes rises 10 to 12 feet in one day, and falls from 6 to 9 feet the next. This river generally checks the falling tendency of the Tennessee. A heavy rainfall and a rapid rise over the Hiawassee will only cause a rise of about 3 feet at Chattanooga. The drainage area above Chattanooga is 21,000 square miles; 2,800 above Clinton; 16,200 above Kingston or Rockwood; 3,400 above Strawberry Plains; 8,300 above Knoxville; 11,500 above Loudon, and 2,200 above Charleston.
>
> Under ordinary conditions, that is, when the ground is fairly moistened and does not absorb very much of the rainfall, and when the rainfall is general over the entire system, the rise at Clinton and Kingston averages 3.9 feet for every inch of rainfall; 3.6 feet at Knoxville, Lou-

don, and Rockwood; 3.8 feet at Charleston, and 4.9 feet at Chattanooga. When a 5-foot stage is at Chattanooga, with the ground moist, and a general and heavy rainfall occurs over the system, the first inch of rain will cause a rise of about 7 feet at Chattanooga, the next 2 inches about 5 feet, and as the river reaches the 25-foot mark the rise is about 3.7 feet to an inch; after it passes the 33-foot mark, or danger line, the rise is less per inch of rainfall, owing to the lowlands that are then flooded. At the 40-foot stage the rise is 2.5 feet for every inch of rain; this is when the rainfall is general and steady; but when the rainfall is exceedingly heavy, and the river is at a 20-foot stage at Chattanooga, the average rise is about 4 feet to every inch of rainfall. This is the average based upon the records from 1879 to 1895, but it has been frequently noticed during the past two years that a general rain of from 1 to 1¼ inches over the system causes only a slight rise in the Tennessee River and tributaries, especially during the summer and fall months. The only solution that can be given for the failure of the rivers to rise to their estimated height is because the ground absorbs a very large portion of the water and very little finds its way into the river channel. It is also noticed that the river in the past few years falls faster than in former years, and when it begins to fall, half an inch of rainfall has little weight in checking its falling tendency. It is evident that the destruction of the forests over the headwaters affects the rises in the river by exposing more absorbing surface, while previous to the removal of the timber the ground was always moist or wet, absorbed very little of the rainfall, and nearly all the water found its way into the river, or, in other words, the blanket has been removed. It will be found to be the fact that heavy rainfall over the south side of the Tennessee River will cause only a slight rise at Chattanooga, but a heavy rainfall over the northern side or entire river system will give a greater and more rapid rise. A rise at Clinton (distant by river 141 miles) takes about sixty hours to reach Chattanooga; Kingston (95 miles) and Rockwood (83 miles), thirty-six hours; Knoxville (154 miles), fifty hours; Loudon (109 miles), forty hours; Charleston (53 miles), twenty-four hours.

In most of the rivers of the world, the occurrence of a special high water at any particular station is usually found to result from the fact that certain floods starting at different times in the different tributaries and flowing down stream at different rates of speed have arrived at the station almost simultaneously. We can but think that the destruction of forests is a minor matter, and that a concurrence of floods from the upper watersheds of the tributaries of the Tennessee is essential to the production of the highest floods at Chattanooga, such as that of March 1, 1867 (58.05 feet), March 1, 1875 (53.98 feet), March 11, 1884 (42.8 feet), and April 3, 1886 (52.2 feet). On page 14 Mr. Pindell notes:

That each successive high water since 1867 has been less than the previous one, and that this is evidently due to the extensive improvements made on the river by the United States Engineer Corps. The discharge of the river at both rising and falling stages was measured in 1893 by the officials of the Weather Bureau. When the river reaches the 3-foot stage that is considered the opening of navigation when the river is rising and the closing of navigation when it is falling. The total number of days when the river was at or above the 3-foot stage has, during the past seventeen years, varied between two hundred and ten and three hundred and thirty-five days as the extreme limits. Occasionally the river is frozen over at Chattanooga, as for instance January 12–14, 1886; January 14–22, 1893, and February 14, 1895. The zeros of the river gauges at the river gauge station above mentioned have the following elevations above mean sea level: Strawberry Plains, 859.79 feet; Knoxville, 806.60; Loudon, 737.10; Rockwood, 699.70; Chattanooga, 630.64; Clinton, 782.30; Kingston, 712.80; Charleston, 684.00.

On page 29 Mr. Pindell reprints a table and note, first published in the Annual Report of the Chief Signal Officer, 1891, in which is given the water stages at Clinton and the corresponding maximum water stages at Chattanooga two days later. For instance, a 5-foot stage at Clinton is followed by a 6.2 stage at Chattanooga, but a 45-foot stage at Clinton by a 52.2 stage at Chattanooga, and proportionately at intermediate stages, but these figures are liable to considerable irregularities because of the unevenness of the rainfall over the valleys of this high region and the fact that so many tributaries must conspire to produce considerable high water at Chattanooga.

MEXICAN CLIMATOLOGICAL DATA.

In order to extend the isobars and isotherms southward so that the students of weather, climate and storms in the United States may properly appreciate the influence of the conditions that prevail over Mexico the Editor has translated the following tables from the current numbers of the Boletin Mensual as published by the Central Meteorological Observatory of Mexico. The data there given in metric measures have been converted into English measures. The barometric means are as given by mercurial barometers under the influence of local gravity, and therefore need reductions to standard gravity, depending upon both latitude and altitude; the influence of the latter is rather uncertain, but that of the former is well known. For the sake of conformity with the other data published in this REVIEW these corrections for local gravity have not been applied. One additional station, Topolobampo, is published at the end of Table II.

Mexican data for September, 1896.

Stations.	Altitude.	Mean barometer.	Mean temperature.	Relative humidity.	Precipitation.	Prevailing direction. Wind.	Prevailing direction. Cloud.
	Feet.	*Inch.*	*° F.*	%	*Inch.*		
Colima (Seminario)	1,663.4*	28.25	78.1	79	5.11	sw.	
Colima	*		79.3				
Guadalajara (Obs. d. Est.)	5,140.8	24.97	69.8	89	7.95	ne.	e.
Guanajuato	6,761.3	23.68	66.6	60	3.20	wsw.	w.
Jalapa	4,757.3	25.55	68.4	86	7.57	n.	
Lagos (Liceo Guerra)	6,274.7	24.15	67.6	65	2.79	ne.	e.
Leon	5,901.0	24.29	68.2	65	4.46	s.	e.
Magdalena (Sonora)			81.1		15.94		
Mazatlan	24.6	29.84	83.8	78	5.60	w.	e.
Merida	50.2	29.86	81.3	80	3.34	ne.	w.
Mexico (Obs. Cent.)	7,488.7	23.07	62.4	69	3.32	n.	ne.
Morelia (Seminario)	6,401.0	23.96	62.4	76	3.74	s.	ene.
Oaxaca	5,164.4	25.06	71.6	73	4.42	nw.	ne.
Pachuca	7,956.3	22.55	57.4	71	3.53	ne.	ne.
Puebla (Col. Cat.)	7,112.0	23.42	65.1	68	4.26		
Queretaro	6,069.7	24.17	67.6	66	2.93	e.	
San Luis Potosi	6,201.9	24.14	69.6	66	1.63	e.	e.
Silao	6,063.1	24.26	70.2	73	1.77	ne.	ne.
Tacubaya (Obs. Nac.)	7,620.2						
Toluca	8,612.4	21.91	57.6	72	3.59	w.	
Trejo (Hac. Silao, Gto.)	6,010.6				7.23		
Zacatecas	8,015.2	22.55	63.3	63	5.17	e.	e.

*These altitudes have been variously published in the original "Boletin," and a clerical error has also slipped into the MONTHLY WEATHER REVIEW. A further explanation will be given as soon as possible.

Mexican data for October, 1896.

Stations.	Altitude.	Mean barometer.	Temperature. Max.	Temperature. Min.	Temperature. Mean.	Relative humidity.	Precipitation.	Prevailing direction. Wind.	Prevailing direction. Cloud.
	Feet.	*Inch.*	*° F.*	*° F.*	*° F.*	%	*Inch.*		
Campeche									
Colima (Seminario)	1,663	28.25	88.2	65.1	76.5	80	8.14	wsw.	
Colima					77.7				
Guadalajara (O. d. E.)	5,141	24.98	80.6	59.0	68.0	82	4.01	sse.	e.
Guanajuato	6,761	23.68	81.0	54.9	64.9	65	4.13	sw.	e.
Jalapa	4,757	25.55	84.4	54.5	66.9	88	7.47	e.	
Lagos	6,275	24.14	81.9	49.8	64.6	71	3.46	sw.	sw.
Leon	5,901	24.30	81.9	52.0	66.0	68	1.22	s.	sw.
Magdalena (Sonora)			88.0	59.9	76.8		4.61	ne.	n.
Mazatlan	25	29.87	89.4	66.2	80.8	80	4.79	nw.	sw.
Merida	50	29.89	96.8	66.7	80.6	76	0.38	ne.	e.
Mexico (Obs. Cent.)	7,489	23.07	75.4	49.1	61.3	71	4.13	nw.	ne.
Morelia (Seminario)	6,401	23.96	75.4	50.0	61.3	76	3.99	s.	s.
Oaxaca	5,164	25.06	86.5	52.5	70.7	66	3.72	nw.	ne.
Pabellon	6,312								
Pachuca	7,956	22.57	76.3	45.1	58.8	73	1.06	ne.	ne.
Puebla (Col. d. Est)									
Puebla (Col. Cat.)	7,112	23.37			64.8	68	3.11		
Queretaro	6,070								
Saltillo (Col. S. Juan)	5,377	24.88	77.5	53.2	63.0	70	8.50	s.	n.
San Luis Potosi	6,202	24.13	77.2	54.0	64.6	72	3.13	e.	w.
Silao	6,063	24.26	77.5	58.5	68.4	76	2.80	w.	w.
Tacámbaro									
Tacubaya (Obs. Nac.)	7,620								
Tampico (Hos. Mil.)	38	29.92	88.5	66.2	77.5	77	3.27	se. & ne.	se. & ne.
Tehuacan	5,453								
Toluca	8,612	21.91	70.9	42.3	56.1	74	3.46	sw.	
Trejo (Hac. Sil., Gto.)	6,011						3.28		
Veracruz	48	29.98	91.9	68.9	80.4	76	5.37	ne.	
Zacatecas	8,015	22.53	77.4	45.9	58.8	73	6.99	sw.	e.
Zapotlan (Seminario)	5,125	25.08	82.8	59.0	68.7		5.74	se. & n.	e.

For text descriptive of tables and charts see page 16.